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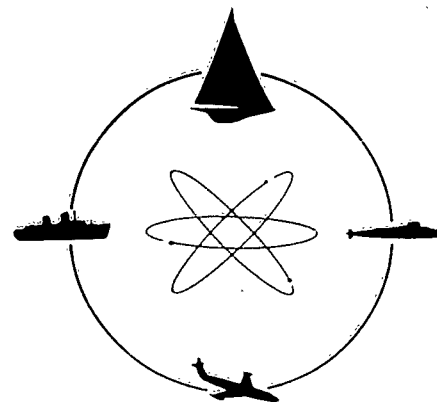
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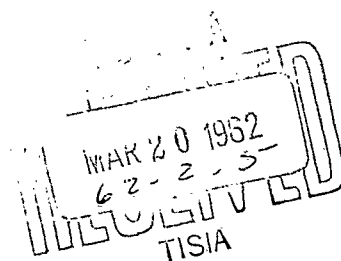
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LABORATORY

QUARTERLY PROGRESS REPORT JULY - SEPTEMBER 1961
RESEARCH PROGRAM ON CONVERSION OF EXPLOSIVE ENERGY

Contract DA-28-017-501-ORD-3450
DL Project LB-2221



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Quarterly Progress Report July - September 1961
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SCOPE OF WORK

The investigation of the effect of seeding explosives in order to enhance their electrical conductivity continued. Measurements of reaction zone resistivity using T-probes were made in both unseeded Comp B and in Comp B seeded with one percent cesium perchlorate. While previous measurements using double probes had shown no effect of seeding under these conditions, the present results indicate that there may be an effect. However, since the difference between the unseeded and seeded results lies within the error bounds attached to each measurement, the observation may not be statistically significant. Firings with higher seeding concentrations and with additional seeding materials are planned.

Effort in the shaped charge collision work was directed toward obtaining a time resolved spectrum of the event by means of a direct-view prism in front of the streak camera. A preliminary result for the impact of a single shaped charge jet on a copper target in a low pressure propane atmosphere was encouraging although considerable work must be done to improve the optical speed and the wavelength coverage. The spectral analysis of the previous shaped charge jet collisions in air and in propane has continued. The spectrum lines that have been identified have been related to initial and final electronic states. On the basis of this information, examination of line shape and intensity can be made to yield details of the physical processes taking place during the collision. This analysis will be reported more fully at a later time.

The mechanical protection of the capacitor bank has been the subject of some work during the past quarter. Test firings of portions of the bank have been performed in order to check that the explosive loading will not exceed the allowable limits of the structure. This has led to several modifications of the central part of the bank in order to decrease the possibility of damage to the collector plate and the cabling to the capacitors. Finally, electrical measurements of bank capacitance and inductance have continued in order to verify the accuracy of the design estimates.

RESULTS OF WORK

A. Firings Conducted

During the past quarter nine firings have been conducted. These are listed in Table 1. One firing is related to the shaped charge jet collision experiment, three are related to capacitor bank structure tests, while the remaining five involve electrical conductivity measurements.

B. Magnetic Field Work

Experimental determination of the electrical characteristics of the capacitor bank continued during this quarter. Measurements of self-inductance were performed on a single unit. Capacitance measurements were made on a few individual units and on a bank of seventeen capacitors.

Measurements of capacitance are obtained in one of two ways: by discharging a single or group of capacitors into a known load resistance and observing the time constant of ringing voltage decay, and by direct bridge measurements. Measurements of the inductive contributions from various parts of the bank are obtained by selectively short-circuiting sections of the bank and observing the short-circuit ringing frequency. A summary of results to date is shown in Table II; indicated values have an accuracy of about 20%. These results are preliminary and will be brought up to date when all contemplated tests are completed.

The overall bank inductance characteristics appear to be consistent with previous design estimates and calculations. The measured inductance per unit length of coaxial cable is higher than that quoted by the manufacturer, however. Further information from the manufacturer as to their test procedures will be requested in an effort to reconcile the difference.

The design of the capacitor bank control and synchronization circuitry has been initiated. A detailed description of the unit will be reported at a later time when the design is completed.

Design, construction, and testing of the bank protective structure are underway. Firings 102, 104, and 105 were intended to check various components of the structure under explosive loading. Slight damage due to explosive shock and metal fragmentation was observed on some components.

Table 1

Firing No.	P.A. No.	Date	Type Charge	Optical Coverage	Purpose
102	none	24 July	Comp B cast in copper tube	none	Test portions of bank protection structure
103	1-1310.	1 Sept.	Single shaped charge on a copper target	Framing camera Streak camera with direct vision prism Spectrograph	Repeat of 101 with time resolved spectrum observation
104	none	19 Sept.	Comp B cast in copper tube	none	Test portions of bank protection structure
105	"	"	"	"	"

Conductivity Firing No.	Date	Explosive	Type Probe	Probe Location	Atmosphere	Confinement
46c	14 Sept.	Comp B	T	Surface	Propane	Unconfined
47c	15 Sept.	"	"	"	"	"
48c	"	Comp B + 1% CsClO ₄	"	"	"	"
49c	18 Sept.	Comp B	"	"	"	"
50c	"	Comp B + 1% CsClO ₄	"	"	"	"

Table II
Bank Inductance and Capacity Measurements

	Inductance (m μ h)		Capacitance (μ f)
	Measured	Design * Estimate	Measured
Capacitor No. (13) and Cable Connection	42	59	7.9
Coaxial Cable (1-1/3 ft)	17	8	--
(17) Capacitors, Collector Plate and Transmission Line	10.3	6.3	175
Capacitor No. (11)	--	--	8.0
Capacitor No. (19)	--	--	7.6

* Based on values reported in Quarterly Progress Report January - March 1961.

Modifications in the design will be made to reduce the possibility of injury to the capacitor bank. Details of the protective structure will be presented at a later time.

C. Conductivity Measurements

Previously, reaction zone conductivity measurements for Comp B and pentolite have been reported⁽¹⁾. The intent of firings 46c through 50c was to measure the conductivity of Comp B charges seeded with 1% CsClO₄ using a T-probe configuration. Since the only seeded charges available at the time were of a different size than that used in previous firings with seeded explosives (1/2 x 2 x 4 in. rather than 1 x 2 x 4 in.), three of the above firings employed unseeded Comp B charges, with dimensions 1/2 x 2 x 4 in. This was done in order to obtain comparative results between seeded and unseeded measurements for explosive charges with the same geometry. The results of these firings are presented in Table III. All firings were performed in a propane atmosphere

(1) Quarterly Progress Report April - June 1961.

with a minimum confinement T-probe assembly described previously. Firing 49c yielded no results since the explosive shattered instead of detonating. A surface reaction zone length of 0.18 mm was used throughout to calculate explosive resistivity. This value has been observed in earlier T-probe measurements with unseeded Comp B⁽¹⁾.

Table III

Summary of Conductivity Firings and Results

Firing No.	Probe thickness (in.)	Explosive	Resistance R_e (ohm)	Error ΔR_e (ohm)	Resistivity ρ_e (ohm cm)	Error $\Delta \rho_e$ (ohm cm)
46c	0.019	Comp B	10.0	4.5	0.72	0.32
47c	0.065	Comp B	12.2	3.4	0.88	0.24
48c	0.065	1% CsClO ₄	5.8	3.9	0.42	0.28
49c	0.019	Comp B	--	--	--	--
50c	0.019	1%CsClO ₄	7.7	4.2	0.55	0.30

Two effects are apparent from the above results. First, unseeded explosive resistivities are about two and a half times larger than comparative values given previously⁽¹⁾. Secondly, a 1%Cs additive appears to enhance the explosive conductivity. The cause for the disagreement between the values reported above and earlier measurements of unseeded Comp B conductivity is not clear. Since the only major change in the experimental set-up was in the use of smaller explosive charges, the influence of charge geometry is strongly suspect. To avoid further complication of conductivity measurements with seeded charges, a standard explosive size (1 x 2 x 4 in.) will be used in future firings.

Compatibility tests for explosives seeded with up to 10% concentrations of CsI and CsClO₄ have been initiated. Fabrication of charges with this degree of seeding will commence as soon as approval is obtained.

D. Shaped Charges

Firing 103, in part a repeat of firing 101 for which spectral information was not obtained, involved the collision of a single copper jet with a massive, stationary copper target in a low pressure propane atmosphere.

In addition, an effort was made to obtain time resolved spectral information for this experiment by incorporating a direct-view prism into the entrance optics of the streak camera.

The gross features of the collision as observed on the framing camera record were similar to that of firing 101. Due to a faulty shutter, no spectral record was obtained from the prism spectrograph. The record from the direct-view prism, streak camera combination indicated the spectral content of the collision luminosity, resolved in time. Figure 1 is a reproduction of the contents of this film record, and illustrates the time sequence in which various portions of the collision spectrum become prominent. Radiation from a mercury source was superposed upon the record prior to firing, to provide known reference spectra.

The regions of observed spectral luminosity are from 5310A to 5330A and from 5860A to 5890A. The breadth of the spectral regions is due to the large slit width employed. The accuracy of wavelength determination over the observed spectral range is about 30A to 50A. The luminosity in the 5860A to 5890A region is attributed to light from sodium impurities and contaminants in the lucite tube assembly. The origin of the luminous region from 5310A to 5330A is not certain; the nearest strong copper radiation in this wavelength region is the 5293A line of neutral copper. The spectral region below 5300A was not imaged on the streak camera film.

Efforts to improve the direct-view prism, streak camera combination to achieve larger wavelength coverage and greater film exposure are underway.

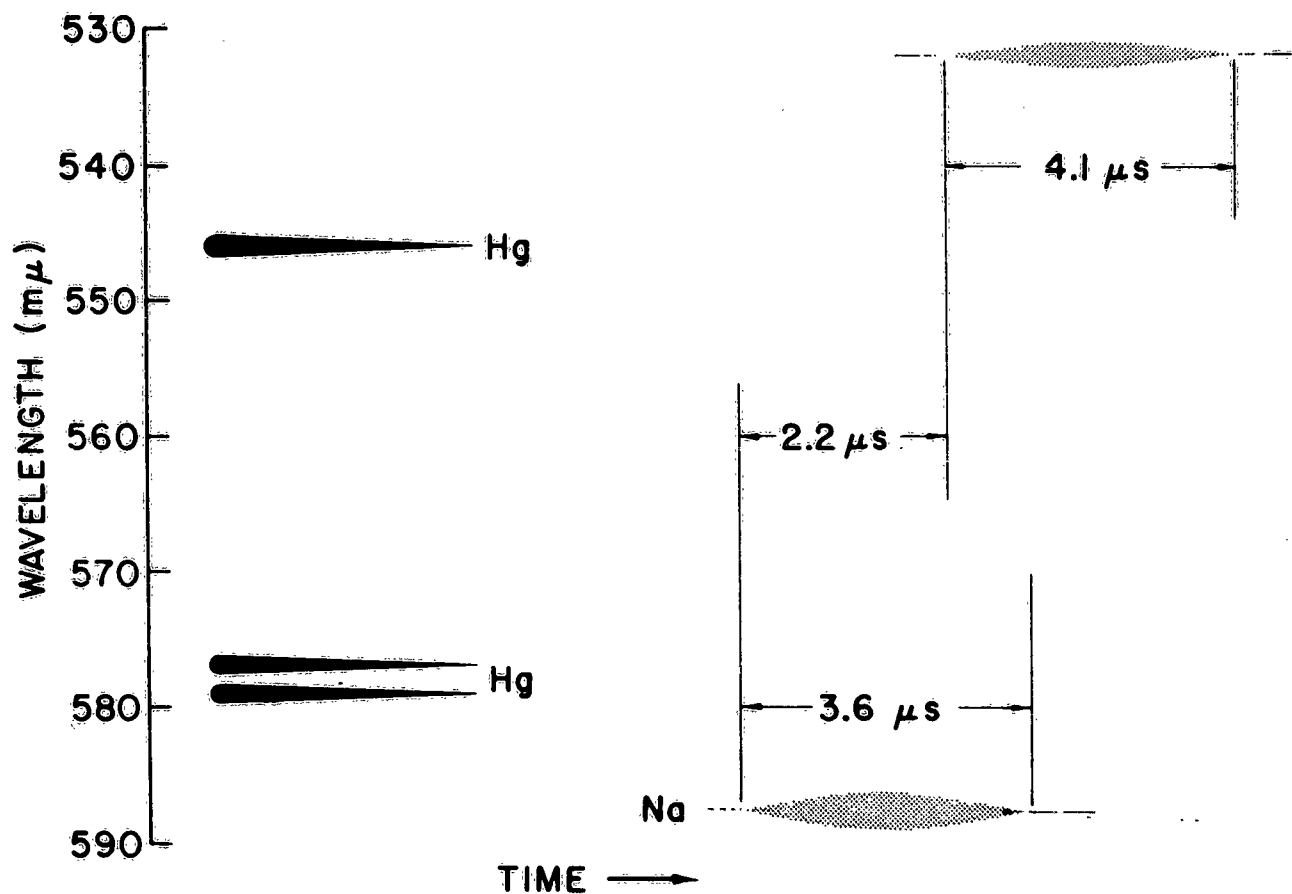


Figure 1

Time resolved spectrum for single
jet collision with copper target
(Graphic reproduction of film record)

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